Southern Pacific Railroad Shasta Route,
Bridge Number 210.52
(Southern Pacific Railroad Shasta Route,
Sacramento River 1st Crossing)
Milepost 210.52
Tehama vicinity
Tehama County
California

HAER No. CA-221

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Department of the Interior
San Francisco, California

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HISTORIC AMERICAN ENGINEERING RECORD

SOUTHERN PACIFIC RAILROAD SHASTA ROUTE, BRIDGE NUMBER 210.52
(Southern Pacific Railroad Shasta Route, Sacramento River 1st Crossing)
HAER No. CA-221

Location:	Milepost 210.52, Tehama vicinity, Tehama County, California UTM: 10-575357-4431120 Quad: Los Molinos, Calif. 7.5', 1952 (photorevised 1969, photoinspected 1976) (west abutment) UTM: 10-575147-4431087 Quad: Los Molinos, Calif., 7.5', 1952 (photorevised 1969, photoinspected 1976) (east ahutment)
Date of Construction:	1898, 1901, 1927, 1929
Engineer:	F.G. Lippert, Phœnix Bridge Company (1898); Southern Pacific Engineering Department (1901, 1927); Engineer, Reehl, American Bridge Company (1929).
Present Owner:	Union Pacific Railroad, 1416 Dodge Street, Omaha NE.
Present Use:	Railroad Bridge.

Significance:

The Southern Pacific Railroad Shasta Route, built as the California and Oregon Railroad and the Central Pacific Railroad between Roseville, California and Portland, Oregon was the first thrust north of the Central Pacific Railroad to tap the Oregon market. Begun in 1863 as the California and Oregon Railroad, the line was finally completed in 1887. Completion of the Natron Cutoff in 1927 saw the north end of the Shasta Route pulled back to Black Butte, California. A final change occurred 1938-1942 when construction of Shasta Dam required replacement of twenty-six miles of the original alignment with thirty-two miles of new railroad. For the purpose of the current project, the Shasta Route was found likely to be eligible for the National Register of Historic Places at the state level of significance under Criterion A for its significance in engineering, transportation history, and the economic history of California and Oregon, and in the development of the West, and under criterion B for its association with E.H. Harriman. The Shasta Route's period of significance is 1863 to 1945, from the beginning of construction in 1863, through the years of its role in the economic development of California and Oregon, to the conclusion of the railroad's achievements in World War II. As contributors to the overall historic property, the route's Common Standard bridges over the Sacramento River were also found to meet criterion C, representing a type, period, and method of construction. Built in 1898, with new approach spans in 1929, Bridge Number 210.52 is the oldest extant swing bridge in California, and is a contributive element of this property.

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I. DESCRIPTION

Bridge Number 210.52 is a single-track railroad bridge whose main span is a 236-foot pin-connected steel through Pratt truss swing span, the oldest extant swing span in California. Fabricated in 1898 by the Phœnix Bridge Company of Phœnixville, Pennsylvania to a modified Southern Pacific Common Standard design by Phœnix engineer, F.G. Lippert, the bridge replaced an earlier structure that had been part of the line's original construction in the early 1870s; piers 4, 5, 6 and 7 also date from 1898. Line improvements in 1901 saw the placement of new stone masonry piers 1, 2 and 3. In 1929, American Bridge Company fabricated four new riveted steel Pratt through truss approach spans for the bridge; one span was 100 feet long, while the other three were 140 feet long. Workers erected these on the earlier piers. Typical of the period, the bridge uses a combination of laced and latticed built-up riveted members, with deep, laced portal struts carrying the date plate on the 1898 span, and the date of the 1929 spans placed in the portal hitch plates. The major beams of the 1898 span bear the rolling mark of the maker, "Phœnix," while those of the 1929 spans bear the rolling mark "Carnegie." The bridge is near the middle of a long reverse curve, and carries the tracks of the Union Pacific Railroad's (formerly Southern Pacific) Shasta Route line in the first of the line's eighteen crossings of the Sacramento River.

II. HISTORICAL INFORMATION

Working to Southern Pacific Common Standard bridge specifications, Phœnix Bridge Company engineer, F.G. Lippert designed a 236-foot pin-connected through Pratt truss swing span bridge to replace an earlier bridge (likely a combination timber and iron through Howe truss) at the railroad's first crossing of the Sacramento River. Working between January and May 1898, Lippert and draftsman, F.E. King completed the plans in time for Phœnix's rolling mills to fabricate the bridge members and ship them to client Southern Pacific that same year for erection. The railroad likely utilized its own B&B (Bridge and Building) forces to erect the new bridge, today the first of what appears to be the largest concentration of Phoenix bridges in California. Complicating this process was the fact that this was--and remains--a single-track railroad, and was at that time the Southern Pacific's only route into Oregon. It remains unclear whether crews were able to keep the old bridge in service while building the new one adjacent, or whether they had to work quickly to remove the old bridge and erect the new span to avoid a lengthy and costly closure of the line. [For a full history of this line and of this undertaking, see the documentation set for the Southern Pacific Railroad Shasta Route (California and Oregon Railroad), HAER No. CA-220.] The fact that the head of navigation of the Sacramento River was well upstream at Red Bluff necessitated the use of a drawbridge at this site.

After assuming control of the Southern Pacific/Central Pacific and merging them with the Union Pacific in 1901, Edward H. Harriman had embarked on a series of huge modernization and reconstruction projects system-wide. Among these was the upgrading or replacement of original bridges on the Shasta Route. The comparatively light construction of the early timber bridges, coupled with years of deferred maintenance and the use of ever-larger and heavier locomotives and cars made them early candidates for Harriman's improvements. The various railroads controlled by Harriman developed a series of standard plans for everything from locomotives to bridges to stations to track spikes, effectively reducing costs. At the Tehama bridge, railroad forces placed new stone masonry piers under the approach spans, likely replacing earlier timber pile bents. While the 1898 Phœnix bridge predates the 1903 adoption of standardized bridge plans by the Harriman railroads, they and other bridges designed to Southern Pacific Common Standard plans must be considered progenitors to that line of structures.

A series of articles on the Harriman standard bridges appeared in *The Railroad Gazette* in 1905 and 1906. In July 1903 Harriman had called a convention of the engineering and maintenance of way departments of the Union Pacific, Southern Pacific, Oregon Short Line, and Oregon Railroad & Navigation Company in order to adopt systemwide standards for construction and maintenance. Meeting in Chicago, the group prepared and adopted standard bridge specifications, and assigned the task of preparing standard bridge plans to the Southern Pacific. Southern Pacific Engineer of Bridges, John D. Isaacs worked from preliminary sketches made at the convention to develop plans for deck plate girder bridges of 20, 30, 40, 50, 60, 70, 80, 90, and 100-foot spans; for riveted through trusses of 100, 110, 125, 140, and 150-foot span; and pin-connected through trusses of 150, 160, 180, and 200-foot span. Isaacs apparently drew heavily on existing Southern Pacific Common Standard plans, for the resulting truss designs are virtually identical with earlier S.P. bridges, including the series of 1901 Phœnix trusses on the Shasta Route. The exception is Bridge Number 301.85. Where the Common Standard plans called for a pin-connected Camelback truss for the 200-foot spans, Bridge Number 301.85 used a Pratt truss for that span length. This was due to the requirement for a skewed crossing, for which the polygonal upper chord of the Camelback truss was unsuited, and so the railroad simply lengthened the standard 180-foot pin-connected Pratt truss by one panel.

In achieving bridges designs of increasing span length, Southern Pacific simply built upon the preceding shorter span to accomplish the requirement. The base design for the truss bridges was the shortest of the riveted spans, the 100-foot Pratt truss. In these standardized designs:

> [T]he panels are of uniform length, 25 ft., and the distance from center of bottom chord to center of top chord is 29 ft. The top and bottom chords are made up of 15-in. 33-lb. channels placed back to back, a 5-16-in. [sic] cover plate being used on the top chord and double latticing on the bottom chord. For the end diagonals a 3/8 in. x 18-in. cover plate, two 15-in. 35-lb. channels and two flats, 3/4 in. x 3-1/2 in. are used. The vertical members at the panel points are I-beam posts made up of four 5-in x 3-1/2-in. x 3/8-in. angles and a web plate 7-16 [sic] in. x 9 in., while the intermediate diagonals are two channels tied with single lacing. For the top lateral bracing double angles are used for the diagonals and laced struts for the transverse braces. Between the bottom chords diagonal angle braces only are used.
>
> The floor system consists of deep floor beams at each panel point riveted to the posts and a pair of stringers 40 in. deep between each floor beam. The ties are notched over the top flanges of the stringers in the usual way. At the ends of the bridge the end floor beams are riveted to the bearing plates which are built up inside the channels forming the bottom chord and the bearing pins pass through the bottom chord and bearing plates. The end bearings, both fixed and movable, are the same as those used for the plate girder bridges. The weight of a span complete is 165,000 lbs.

The longer versions of the riveted through truss used the same basic 25-foot panels and 29-foot vertical dimension, increasing material size and weight as necessary, and using additional panels to achieve the desired length. The pin-connected trusses built on these basic building blocks as well, with the 150-foot pin-connected span being the design upon which the longer bridges were based:

> There are six panels, the two center panels have double diagonals, one of which consists of two bard 7 in. x 1-1/8 in. and the other of a single 5 in. x 1 in. The intermediate panels have single diagonals each 7 in. x 3/4 in. The top chord is built up of a cover plate 21 in. x 3/8 in.; two webs 18 in. 2 1/2 in. spaced 14 in. apart; two top flange angles 3-1/2 in. x 5 in. x 7/8 in. The end diagonals are fabricated in

> a similar manner to those shown in the 150-ft. riveted through truss bridge which was illustrated last week [September 1, 1905], the only difference being the distance between and in the thickness of the web plates, which are spaced 14 in. apart instead of 13 in. and are 3/4 in. in thickness instead of 5/8 in. The bottom chord is made up of two 15-in. 45-lb. channels and two 12-in x 9/16-in side plates. The estimated weight of one span complete is 304,000 lbs. as against 311,000 lbs. for the 150-ft. riveted through truss span shown last week.

Thus the pin-connected trusses had the advantage of a lighter dead load than a comparable all-riveted structure. For the 160-foot span, the number of panels and method of bracing remained the same, but the top chord used heavier cover and web plates, and the bottom chord used heavier channels and side plates. This bridge weighed in at 348,000 pounds. The 180-foot bridge was a 160-foot span lengthened by one panel to a total of seven, and using somewhat heavier materials in top and bottom chords. This bridge topped two hundred tons, weighing 417,000 pounds.

For the 200-foot pin-connected bridge, Isaacs turned to the S.P. Common Standard bridge plans for a Camelback truss. This design, a variation of the basic Pratt truss that utilized a polygonal upper chord of five slopes, was more useful for long spans since the curved upper chord gave the trusses more depth. The Camelback also cost more than a Pratt of comparable length, since it required more material. Again, the design of this Harriman standard bridge type is virtually identical to the several 1901 Camelback trusses fabricated by Phœnix for the Shasta Route.

Southern Pacific also provided the Harriman system lines with standard specifications for bridges, and it is useful to list those as a basis for understanding the conception, fabrication, design, and erection of the resulting Common Standard structures:

> GENERAL.
>
> 1. *Preliminary Data.* The Railroad Company will furnish either general plans or such masonry diagrams and other data as are required to define the span and general characteristics of the structure.
>
> 2. *Approval of Plans.* Upon receipt of these, the contractor shall prepare detail plans in strict conformity therewith, complete sets of which shall be submitted in triplicate to the Railroad Company for approval.
>
> 3. *Detail Drawings.* These plans shall include:
>
> (a) A stress sheet, which shall show a truss diagram, the dead and live load assumptions and the minimum and maximum stresses, the net area of cross-section, and the make-up of each member of the bridge.
>
> (b) An erector's diagram which shall show clearly the marking and position of each member of the bridge.
>
> (c) Detail shop drawings of all members and their connections.
>
> 4. *Commencement of Work.* Upon approval of these plans, but not before, work on the structure may be begun, and it is expressly provided that such approval in no way releases the contractor from responsibility for drafting or shop errors.
>
> 5. *Alterations.* After plans have been approved, alterations will be permitted only upon the written instructions of the Railroad Company.
>
> 6. *Final Drawings.* Before shipment of material shall have begun, one complete set of plans on tracing cloth shall be furnished by the contractor without extra charge.
>
> 7. *Patents.* All claims for royalties on patented devices used in any structure shall be paid by the contractor.
>
> 8. *Inspection.* Such persons as the Company may appoint shall have free access at all times to the working drawings and shops of the contractor, for the purpose of

examining the plans and inspecting the materials and mode of manufacture and construction.

MATERIALS

9. *Floor System.* Ties and guard timbers, rails and rail fastenings, as well as the necessary irons and labor of putting them in place, will be furnished by the Railroad Company.

10. *Kinds Used.* All parts of the structure, except ties and guard timbers, shall be of open-hearth steel; but cast steel shall be used for the rollers of swing-bridges, and cast iron and cast-steel may be used in the machinery of swing-bridges and, in special cases, for wall plates. Expansion rollers must be of bar steel or of cast steel of equal strength.

11. *Quality and Tests.* All steel shall be made by the open-hearth process and shall conform to the following requirements:

	Medium.	Rivet.
Maximum phosphorus:		
Basic, per cent	0.04	0.04
Acid, per cent	.08	.08
Maximum sulphur	.05	.05
Ultimate tensile strength, in lbs. per sq. in.	60,000 to 68,000	46,000 to 54,000
Elastic limit, lbs. per sq. in.	33,000	26,000
Min. elongation in 8 ins., per ct.	22	26
Min. reduction of area, per ct.	37	. .

12. In addition to above test, pieces cut from material three-fourths of an inch thick or less should bend to close contact when cold without showing signs of cracking, and rivet steel when nicked and bent 180 degrees around a bar whose diameter is equal to the thickness of the rod shall not break with a sudden square fracture, but must show a gradual break and a fine silky homogeneous fracture.

13. The tensile strength, elastic limit and elongation shall be determined by loading to point of rupture a specimen of not less than one-half square inch in section and not less than one-fourth of an inch in thickness, cut and planed or turned from a full-size section to a uniform section at least 9 inches in length, on 8 inches of which the elongation shall be measured.

These test specimens shall be cut by the mill from finished material selected by the inspector, and shall be so selected that the different sizes and shapes in the order shall be as nearly represented as possible.

No final tests will be made on specimens rolled especially for test pieces.

Every melt or blow as well as every furnace head from which material is furnished must be represented by the tests.

A bending test shall be made with each tensile test, if required.

The contractor must promptly furnish the inspector with copies of invoices of all materials shipped to fill these orders. Rejected material must not be shipped from the mill to fill any orders.

14. *Eye-Bar Tests.* Full-size eye bars shall be tested to destruction. In general the number of bars tested shall be about 4 per cent of the entire number of bars in the order, but in no case less than two bars from each order or from a single span, and selected so as to represent as well as possible the various sizes in the order. Test bars must be rolled, forged and finished at the same time and in the same manner as the entire order. From the finished bars the inspector shall select the bars to be tested, and the bars so tested shall conform to the requirements of Article 11 within a variation of 8 per cent.

LOADS

15. All structures shall be proportioned to carry the following loads:

(a) *Dead.* The total weight of metal in the structure.

(b) *Floor.* A floor weighing 500 pounds per lineal foot of each track, which includes rails, rail fastenings, ties and guard timbers.

For the purpose of calculating stresses of trusses, three-quarters of the sum of the dead loads "a" and "b" shall be considered as applied to panel points of the loaded chord and one-quarter at panel points of the unloaded chord. The total weight of metal (a) in the structure as built, together with the weight (b) of the floor, must not exceed the dead load used in calculating the stresses.

(c) *Moving.* A moving load for each track consisting of trains, each composed of two consolidation locomotives [Note: a consolidation was a steam locomotive with a 2-8-0 wheel arrangement, that is, a two wheel pony truck, eight driving wheels, and no trailing truck] (with weights distributed as per the following diagram) [Note: not reproduced in this report], followed by a uniformly distributed load of five thousand (5,000) pounds per lineal foot. The maximum stresses arising from all positions of this moving load must be provided for.

16. *Wind.* The wind pressure shall be assumed acting in either direction horizontally:

(a) On the loaded structure at 30 pounds per square foot, on the exposed surface of all trusses and the floor system, as seen in elevation, in addition to a train surface of 10 feet average height, beginning 2 feet and 6 inches above base of rail, moving across the structure.

(b) On the unloaded structure at 50 pounds per square foot on the exposed surface of all trusses and the floor system as seen in elevation. In no case, however, shall the bracing of the loaded chord be designed for a less pressure than 500 pounds per lineal foot, of which 200 pounds per lineal foot is to be considered as uniformly distributed, and 300 pounds per foot as moving load, and in no case shall the bracing of the unloaded chord he designed for a less pressure than 150 pounds per lineal foot considered as uniformly distributed.

(c) On the members of viaduct towers, as seen in elevation, 60 pounds per square foot on the loaded, and 100 pounds per square foot on the unloaded structure.

17. *Wind Anchorage.* In determining the requisite anchorage against wind pressure for the loaded structure the train shall be assumed to weight 800 pounds per lineal foot.

18. *Braking Force.* For trestle towers and similar structures, also for the attachments of the fixed ends of all structures, the force induced by suddenly stopping the moving load (see Article 15, Clause "c") on any part of the structure shall be considered, the co-efficient of friction of the wheels upon the rails being assumed at 0.20.

19. *Centrifugal Force.* If the structure is on a curve a centrifugal force equal to 4-1/2 per cent of the moving load (see Article 15, Clause "c") on all tracks for each degree of curvature must be provided for. This force is to be applied 5-1/2 feet above base of rail.

STRESSES

20. *Conventional Distances.* In calculating stresses the following conventional distances shall be assumed:

Lengths of plate girders: center to center of end bearings.

Lengths of trusses: center to center of end pins.

Lengths of stringers: center to center of floor beams.
Lengths of floor beams: center to center of trusses.
Lengths of web members and laterals: center to center of chords measured along the member.
Depths of plate girders: back to back of flange angles where cover plates are used, and center to center of gravity of flange angles where no cover plates are used.
Depths of pin-connected trusses: center to center of chord lines.
Depths of riveted trusses: center to center of gravity of chord sections.
21. *Working Stress.* The greatest working stresses, in pounds per square inch, shall be as follows:

TENSION

Rolled beams used as girders: 7,000 (1+Min. divided by Max.)
Bars, forged ends: 8,000 (1+Min. divided by Max.)
Plates or shapes, net section: 8,000 (1+Min. divided by Max.)
Floor beam hangers, plates or shapes for net section: 6,000
Outside fibers of pins: 18,000

SHEARING

Pins and rivets: 7,500
Hand-driven rivets, 20 per cent less unit stresses. For knee bracing increase unit stresses 50 per cent.
Webs of plate girders: 6,000

BEARING

Projection semi-intrados, pins and rivets: 15,000
Hand-driven rivets, 20 per cent less unit stresses. For knee bracing increase unit stresses 50 per cent.

COMPRESSION

Rolled beams used as girders, and compression members having lengths less than forty times the least radius of gyration; see Tension, plates or shapes, previously given.
Lengths more than forty times the least radius of gyration; reduce by the following formulas:
For both ends fixed: b = 8,000 (1+Min. divided by Max.) - 35 times l divided by r
For one or both ends hinged: b = 8,000 (1+ Min. divided by Max.) - 45 times l divided hy r

(b) Equals allowable working stress per sq. in.
(l) Equals length of member in inches.
(r) Equals least radius of gyration of section of member in inches.

No compression member shall have a length greater than 45 times its least width.

Outside fibers of pins: 18,000
22. *Alternate Stresses.* All members subject to stresses of both tension and compression shall be designed to sustain both stresses with eight-tenths of the smaller added to each, the minimum of each being taken as zero.

23. *Combined Loads*. For combined live, dead, wind and centrifugal stresses, increase the preceding unit stresses 30 per cent above live and dead load unit stresses.

24. *Bed Plates*. All bed plates shall be of such dimensions that the greatest pressure per square inch, due to any or all causes combined, upon stone masonry shall not exceed 300 pounds, and upon other masonry 250 pounds.

25. *Friction Rollers*. In no case shall the pressure per lineal inch of friction roller at expansion end of superstructures exceed 400 times the diameter of the roller in inches.

26. *Swing-Span Rollers*. The greatest pressure in pounds per lineal inch of face of rollers under swing-bridges shall not exceed, at rest 300 times, nor in motion 150 times the mean diameter of the roller in inches.

27. *Counter Systems*. Counter systems in all spans must, in addition to the requirements arising from the above loads and unit stresses, be designed to take care of a moving load 80 per cent greater than that given in Art. 15, Clause "c," with an allowance of 80 per cent increase in unit stress wherever such increases would cause heavier dimensioning or require additional counters.

28. *Transverse Loads*. All horizontal or inclined members must be proportioned to sustain the combined stresses due to direct compression or tension and to the weight of the members and their transverse loads, but the combined unit stress from these causes must not exceed the unreduced direct unit stress by more than 10 per cent.

30. *Initial Stress*. All struts must be proportioned to resist the resultant due to an initial stress of 10,000 pounds on all rods attached to them whenever this is in excess of the maximum stress produced from other causes.

31. *"I" Beams*. All "I" beams shall be proportioned by their moment of inertia.

32. *Web and Flange*. No part of the web-plate shall be estimated as flange area in proportioning plate girders except that part included between the top flange angles or girders with double top flanges.

GENERAL DETAILS

33. *Strength and Simplicity Required*. In general, strength and simplicity shall be the first considerations in design of any structure and any arrangement of members which introduces uncertainty or indeterminateness of stresses must be avoided.

34. *Types Preferred*. The types of bridges preferred are as follows:

For spans up to 19 feet in length: Rolled Beams.

For spans from 19 feet to 100 feet in length: Plate Girders.

For spans from 100 feet to 150 feet in length: Riveted Trusses with inclined end posts.

For spans of 150 feet and over in length: Pin-Connected Trusses with inclined end posts.

35. *Clearance*. A clear section, as per accompanying diagram [Note: diagram not reproduced in this report], must be provided for single track on tangent. The width must be increased so as to allow the same minimum clearance on curves and on double track.

36. *Stringer Spacing*. Track stringers, as a rule, must be spaced 7 feet from center to center on tangents, with necessary allowance on curves. Track stringers must be offset or shifted laterally on curves so as to keep the center of the track approximately midway between the stringers.

37. *Girder Spacing*. Girders of deck-plate spans shall be spaced as follows, with necessary allowance on curves:

For lengths 60 feet and under, center to center of girders, 7 feet.
For lengths 60 feet to 80 feet, center to center of girders, 8 feet.
For lengths from 80 feet to 100 feet, center to center of girders, 9 feet.

38. *Truss Spacing*. The trusses of single-track deck lattice spans shall he spaced as follows, with necessary allowance on curves:

For lengths from 100 to 110 feet, center to center of trusses, 10 feet.
For lengths from 110 feet to 130 feet, center to center of trusses, 12 feet.
For lengths from 130 feet to 150 feet, center to center of trusses, 14 feet.

The trusses of deck pin-connected spans shall be spaced as directed in each particular case.

39. *Through Girders*. Through plate girders shall conform to Articles 35 and 36.

40. *Friction Rollers*. All bridges over 75 feet in span shall have at one end segmental steel friction rollers not less than 6 inches in diameter, running between parallel planed surfaces; but cylindrical rollers 4 inches in diameter may be used when desired.

All bridges under 75 feet span shall be fixed at one end, and shall be free to move on plane surfaces at the other end.

41. *Pin Bearings*. All spans of over 75 feet shall have pine [sic] bearings at each end.

42. *Fixed End*. Where practicable the fixed end of a span must be as follows--letters indicating order of importance:

(a) At tbe end connecting with trestle approach.
(b) At one abutment.
(c) At the lowest pier.
(d) When the structure is on a grade, in the absence of other governing conditions, at the down grade end.
(e) In structures consisting of several spans, anchorages to be arranged so that no pier shall carry the fixed end of more than one span.

43. *Stiff Members*. All trusses of 6 panels or less shall have stiff members throughout built of plates and shapes with riveted connections.

44. Trusses over 150 feet span shall have stiff lower chords in the two end panels at each end.

45. Hip suspenders and long verticals shall be stiff members built of plates and shapes.

46. *Laterals*. Stiff members built of plates and shares are required for both top and bottom lateral bracing of deck and through bridges. Where the details permit, the bracing must be connected to the lower flanges of stringers as well as to the lateral plates.

47. *Sway Bracing and Diaphragms*. In deck bridges there shall be transverse sway bracing at each panel point; the transverse bracing between the main inclined end-posts shall be sufficiently strong to transmit the accumulated upper chord wind pressure to the masonry. In deck-plate girders there shall be cross-frames (or diaphragms) not more than 16 feet apart, and at each end of each span.

48. *Viaduct*. Stiff members built of plates and shapes are required for both longitudinal and transverse bracing of viaduct towers.

49. *Tower Girders*. Tower girders shall be securely attached at each end to the tops of tower posts and provision made for expansion at one or each intermediate span.

50. *Trestle Bents*. Trestle bents and viaduct towers must have lateral horizontal still members at top and bottom. Viaduct towers must bave longitudinal horizontal still members at bottom. Bolts connecting girders to viaduct or trestle bents must have nuts and split keys.

51. *Floor Beams.* Unless the conditions forbid, floor beams shall be built into posts above or below the pin, and track stringers shall be built into floor beams.

52. *Portals, End Posts, Sway and Knee Bracing.* All through spans shall have portals at each end of the span, connected rigidly to the end posts, with the year of erection cut out of the portal plate, using Roman figures not less than 8 inches high. Portals shall be as deep as the specified head room will allow, and provision shall be made in the end posts for the bending stress produced by the wind pressure. Where head room will allow, all intermediate posts must have transverse sway bracing; where this is not admissible, efficient knee bracing must be provided. In through spans, where knee braces are used between the struts of the upper lateral system and the posts, provision must be made for a rigid connection between the posts and the upper chords.

Year Plate. To one plate girder of each pair, on the outside of web and as near the center as practicable, shall be riveted a small neat cast-iron plate with the year of erection only thereon in raised Roman figures 6 inches high. A similar plate shall be riveted to the upper surface of an inclined post at each end of each deck span.

53. *Ties.* Ties shall be so gained over stringers, etc., that there will be no camber in the floor when there is no moving load upon the structure. The net depth of ties shall not be less than 7-1/2 inches at center of span nor less than 9-1/2 inches at the ends of span; width of ties not less than 8 inches; spacing not more than 4 inches apart.

54. *Trestle Connections.* The supports or shelf angles under the ends of wooden trestle stringers connecting with steel spans, must be 8 inches wide (lengthwise with trestle stringer) and so constructed as to give a rigid bearing for this width and entirely across each group of trestle stringers.

55. *Camber.* The camber shall be at least one fifteen-hundredths of the span; the panel points of pin structures to be in the arc of a true circle.

56. *Minimum Sections.* In no case shall any counter or diagonal rod have less area than three square inches.

57. *Upset Rods.* All rods with screw ends must be upset. The area at root of thread in upset ends shall be greater than the area of the rod by at least seventeen per cent. All turnbuckles must have lock nuts placed outside the turnbuckles.

58. *Angle Connections.* Angles in tension shall be connected by both legs.

59. *Bed Plate.* When practicable, adjacent ends of consecutive spans shall have a common bed-plate. When the height of bed-plate exceeds 6 inches, separators must be introduced or other provisions made to insure horizontal stiffness.

60. *Stiffeners.* Stiffeners must be used at intervals equal to the depth of girder or track stringer whenever the ratio of the unsupported depth of the web to its thickness exceeds fifty; also at points of concentrated loads. There shall be two pairs of stiffeners at the end bearings of girders, these four stiffeners to take care of the maximum end shear.

61. *Details.* Details must be so designed that all parts can be cleaned and painted, and should be 10 per cent stronger than the main members connected by them. No closed columns or pockets will be allowed.

62. *Top Flange Area.* Top flange of built beams shall have the same gross area as bottom flange when of the same cross-section.

63. *Minimum Thickness.* No material less than five-sixteenths of an inch thick shall be used except for fillers, and no webs of girders or chords shall be less than three-eigbths of an inch thick.

64. *Cover Plates.* Where two or more cover-plates are used on the flanges of girders they shall be of equal thickness, or shall decrease in thickness outward from the angle; the cover-plate shall not extend more than 5 inches, or eight times the

thickness of plate, beyond the outer line of rivets. In cover-plates more than 14 inches wide, four lines or [sic] rivets shall be used. Where practicable, the bottom cover-plate of the top flange must run the whole length of the girder.

65. *Rivet Pitch.* Pitch of rivets shall not be more than 6 inches nor more than sixteen times the thinnest plate connected, nor less than three times the diameter of rivets.

66. *Temperature.* Variations of 150 degrees Fahr. in temperature shall be provided for.

67. *Anchorage.* The roller end in every truss shall he free to move longitudinally under changes of temperature, but they must be securely anchored against lifting or moving sideways. The fixed end in every case shall be rigidly secured to the pedestal and the pedestal anchored to the masonry so that no motion can take place in any direction.

68. *Reaming.* Rivet holes of the following portions of the structure shall be punched to a diameter three-sixteenths of an inch smaller on the die side than the finished diameter of the hole, and shall be afterward reamed to a diameter one-sixteenth of an inch larger than that of the cold rivet:

(a) All tension members, except lateral and transverse bracing systems.
(b) Flanges, webs and all connections of floor systems.
(c) Flanges of all plate girders.
(d) Main compression members.

69. *Pin Projection.* The threaded ends of all pins must project at least one-fourth of an inch beyond the outside face of the nut.

70. *Members Straight.* All members must be straight between points of connection.

71. *Overhanging Beams.* No portion of a beam or girder intended to carry a moving load must extend beyond the supports. This does not apply to overhanging the beams when necessary in the turntable of swing spans.

72. *Pier Bents.* Pier bents of deck spans must be footed upon an extension of the lower chord and be a right angles to grade.

WORKMANSHIP

73. *Workmanship.* All workmanship must be first-class in every respect.

74. *Finish.* All abutting surfaces of compression members, except flanges of plate girders which must be fully spliced, must be planed or turned so as to ensure even bearings.

75. *Annealing.* In all cases where it is necessary to partially heat a steel member, the whole piece must be subsequently annealed.

76. *Limits of Error.* No piece having an error of one thirty-second of an inch between centers of pin holes, or one-fiftieth of an inch in the diameter of the pin or its hole, will be accepted.

77. *Built Members.* Built members, when finished, must be true and free from twists, kinks, buckles, or open joints between component parts.

78. *Rivet Holes.* Rivet holes must be accurately spaced and exactly opposite each other.

79. *Rivets.* Rivets must be of the best quality or rivet steel, must completely fill holes, and must have full heads. Rivets for field work must have full and perfect heads, with underside of head square to shank; shanks must be of a uniform circular section throughout and cut square at end, and must be free from projections or imperfections which would prevent the head from fitting closely before rivet is driven.

80. *Eye-Bars.* Eye-bars shall be die forged without welds.

81. *Painting in Shop*. All surfaces inaccessible after assembling must be painted with a good quality of red lead paint before the parts are assembled. After work is finished at the shops, it shall be cleaned of all loose scale and rust, and thoroughly and evenly covered with one coat of red lead paint before shipping. All planed or turned surfaces must be coated with white lead and tallow.

82. *Blocking*. Projecting members, liable to be bent or injured in transit, must be blocked with wood before shipment, in such a way as to protect them from injury in handling.

83. *Straightening Material*. All material must be thoroughly straightened before being laid off or worked in any way.

84. *Fillets*. No sharp unfilleted angle will be allowed anywhere, and whenever plate or shape has been cut into, the fillets as well as the cut must be finished so that no sign of the punched or sheared edge remains.

85. *Rivet Holes*. In punched work the diameter of the die shall not be more than one-sixteenth of an inch greater than the diameter of the punch.

86. *Assembling*. Riveted members must have all parts will pinned up and drawn together before riveting up, so that when finished they will be free from open joints and the component parts will lie close on each other.

87. *Machine Driven Rivets*. All rivets must be driven by machine where possible, and where not possible pneumatic driven rivets will be preferred to hand rivets.

88. *Reaming Connections*. Wherever practicable, reaming must be done after all pieces which are to be fastened together by the same rivets have been assembled. If necessary to take the pieces apart for shipping or handling, the respective pieces reamed together must be so marked that they may be reassembled in the final setting up. No interchanging of pieces after reaming will be allowed.

All field connections in the floor system must be reamed to a fit while the members are assembled in the shop, or to an accurate steel template not less than one inch thick.

89. *Milling*. All floor beams and track stringers must be milled on both ends to correct length, and end connection angles must be accurately fitted so that not more than one-sixteenth of an inch will be taken off of these connection angles at their roots.

90 *Stiffeners*. All stiffeners must have a tight fit between upper and lower flanges of girders.

91. *Inspection*. No material shall be rolled or work done before the Railroad Company has been notified where the orders have been placed and arrangements have been made for the inspection.

92. Complete copies of mill orders and plans must be furnished to the inspector, and he must be notified in time to be on hand when work is begun on his orders.

93. The contractor must furnish all facilities for inspecting the workmanship and testing the quality of all material furnished on the order at the mill or shop where the material is manufactured.

94. The inspector must be given reasonable facilities to check the weights of finished members before shipment. Not more than 2-1/2 per cent excess weight over figured weight will be paid for by the Railroad Company.

95. *Turned Bolts*. Wherever bolts are used in place of rivets the holes must be reamed true to size after work is assembled, the bolts must be turned to a driving fit and their threads reduced one-eighth of an inch in diameter under size of finished bolts. A small washer, one-eighth of an inch thick, must be used under nut.

96. *Pilot and Driving Nuts*. At least one pilot and driving nut must be furnished with every twenty pins or less of one size for every size of pins.

FINAL TEST

97. *Test.* The completed bridge when tested by a train moving at the rate of 60 miles an hour shall not deflect more than one fifteen-hundredth of its span, and must return to its original camber after the passage of the train.

In looking closely at the 1898 swing span of Bridge Number 210.52, it is easy to recognize the genesis of the Harriman standard bridges in this earlier Southern Pacific Common Standard structure. Applying all points of the later Harriman specifications, from choice of hridge type for the distance to be spanned, to materials, to such details as the spacing of rivets or portal date plates would have resulted in virtually the same hridge being built.

In 1927, Southern Pacific forces began work on plans for renewing the approach span piers at Bridge Number 210.52 in preparation for the replacement of the approach spans. The pier work consisted of lowering the piers by removing a course of stone masonry beneath the cap stone, placing a course of concrete slightly thinner than the stone course removed, and replacing the cap stone on the concrete course. This was necessary because the bottom chords of the new riveted approach spans would be deeper than the pin-connected bottom chords of the original approach spans; without the pier modifications, the deck of the new approach spans would have been too high in relation to the swing span. [The height differential in bottom chords between swing span and approach spans can he most clearly seen in photos HAER-CA-221-4 and -5.]

With the pier modifications complete, Southern Pacific contracted in 1929 with the American Bridge Company to fabricate four new approach spans for Bridge Number 210.52. These would be a single 100-foot riveted steel Pratt through truss on the east end of the swing span, and three 140-foot riveted steel Pratt through truss spans on the west end. Working to Southern Pacific Common Standard 1925 specifications, American Bridge engineer, Rechl handled the design at the company's Ambridge No. 5 plant at Ambridge, Pennsylvania. Since Southern Pacific would soon use American Bridge forces to handle the erection of its new Martinez-Benicia Bridge, it is likely that they--rather than Southern Pacific crews--also built these new riveted approach spans as well.

Four years after completion of the new approach spans, and as a result of the Great Depression, traffic on the upper Sacramento River dwindled and in 1933 the War Department allowed the swing span to be closed to navigation. The railroad has since removed the bridge's control cabin and most of the operating machinery. Today, carrying tracks of continuous welded rail that ensure it cannot be opened, the swing span of Bridge Number 210.52 serves as a reminder of an earlier era.

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IV. PROJECT INFORMATION

As a result of the 1996 merger of the Union Pacific and Southern Pacific Railroads, a federal undertaking under the jurisdiction of the Surface Transportation Board of the U.S. Department of Transportation, and in order to accommodate freight trains utilizing longer and taller cars and loads--tri-level auto rack cars and cars carrying double-stacked containers--the Union Pacific will need to increase bridge clearances on the former Southern Pacific Shasta Route. The affected bridges, built between 1898 and 1929, are contributing elements of the National Register-eligible Southern Pacific Shasta Route Historic District. The work may impact character-defining elements of the bridges. Inasmuch as this would cause an adverse effect to the bridges, Union Pacific, in consultation with the California SHPO, has elected to record the bridges for the Historic American Engineering Record. Documentation was carried out by P.S. Preservation Services, John Snyder Field Director and Historian, and Ed Andersen, Photographer. Photos were made in October 1997, and research was carried out from November 1997 through June 1998.